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sum of one group of 36 readings be C_p. Four groups of 12 readings each, namely, the readings of the two unsymmetrical microscopes at the same settings; let the sums be denoted by C'_p ($p=1, 2, 3, 4$), then it is not difficult to see that

$$\Sigma_s C_{s\,.\,p-s} = C_p + C'_{p-1}$$
$$\Sigma_s C_{s\,.\,p} = C_p + C'_p$$

and the eight normal equations become:

$$8X_p + 6\Sigma y + 6Z_p + 2Z_{p-1} = C_p + C'_{p-1}$$
$$6X_p + 2X_{p+1} + 6\Sigma y + 8Z_p = C_p + C'_p$$

or eliminating the Z's:

$$12(2X_p - X_{p-1} - X_{p+1}) = 8C_p + 8C'_{p-1} - 6C_p - 6C'_p - 2C_{p-1} - 2C'_{p-1}$$
$$= 2C_p - 2C_{p-1} + 6C'_{p-1} - 6C'_p$$

Solving this difference equation

$$6(X_p - X_{p-1}) = 3C'_{p-1} - C_{p-1}$$

plus an arbitrary constant, which is determined by the condition

$$\Sigma(X_p - X_{p-1}) = 0.$$

Hence the following precepts for computing are obtained:—

Form the four quantities $D_p = 3C'_p - C_p$ (to do this subtract the sum of the readings of the six symmetrical microscopes for each setting of the circle from three times the sum of the two unsymmetrical readings, and then add the 24 quantities thus obtained in four groups of six); then

$$6X_p = \tfrac{3}{8}(D_{p-1} - D_p) + \tfrac{1}{8}(D_{p-2} - D_{p-1})$$

and if the weight of a single observation be unity, the weight of the determination of $\frac{X_p}{6}$ is $\frac{144}{5} = 28 \cdot 8$.

On a modified form of Revolving Occulter for adapting the exposure of the Sun's Corona to its actinic intensity at all distances from the Moon's limb. By Professor David P. Todd, Director of Amherst College Observatory.

(*Communicated by the Secretaries.*)

Fifty years have now elapsed since the Sun's corona was first daguerreotyped. A heliometer with uncorrected objective was used, and it is not certain that the clockwork was sufficiently good to have prevented the blurring inseparable from the long exposure required by the relatively insensitive silver iodised surface. Still, the daguerreotype of the corona of 1851 compares very favourably with many photographs of the most recent

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eclipses, although the latter are often taken with specially corrected objectives, practically perfect clock-motion, and relatively short exposure.

De la Rue, in the Spanish eclipse of 1860, made the next successful attempt, using wet collodion plates; and so fine were his photographs that they proved conclusively the connection of the corona with the Sun and not the Moon, because their detail was so sharp that the dark disc of the latter was shown passing over one filament after another; and subsequent measurement showed that these were stationary with reference to the Sun throughout totality.

Lord Lindsay's Indian expedition in 1871 brought back perhaps the finest photographs of the corona ever taken—again wet plates, with excellent lenses and clockwork, and the expert manipulation of his photographer, Mr. Davis.

I think it an open question whether the old-fashioned wet-plate pictures of the corona will ever be surpassed by the modern and more convenient dry-plate ones, except by the adoption of some device, mechanical and automatic, for reducing the excessive actinic effect of the innermost corona, and the consequent halation obliterating all detail. To this end I constructed a device for photographing the corona in rings, described elsewhere;* but being satisfied that the scheme of Mr. Burckhalter is superior to it, I have re-designed and constructed a revolving occulter for the eclipse of 1901 May 18. It will be seen that I have overcome the most serious objection to the original form of the device—namely, the necessity for perforating the sensitive glass plate.

The illustration (Plate 16) readily shows how this is accomplished. A light frame, $w\,x\,y\,z$, slides in grooved ways about one inch inside of the focal plane. The circular field is $a\,b$, the size of the Moon $d\,e$; and when the occulter is not in use the frame is pulled out so that $d\,e$ is central over c. Photographs are here taken, as usual, so as to compare directly with those taken later by the same instrument, but modified by the occulter.

By pushing in the frame (up in the figure) to an accurate stop, which movement takes but half a second, c' takes the position in the field formerly occupied by c. The clockwork, k, is set going, and the exposure begins. By means of a light cord, $g\,h$, running round a pinion of k and the rim, $t\,u\,v$, the latter is revolved several turns per second. This rim is, of course, made very light, spun from thin aluminium, and exactly circular in all its sections. Its weight is but two ounces, and instead of turning on a central pivot, its outer edge slips through three accurately-adjusted friction wheels, $q\,r\,s$. The best disposition of these is shown in the illustration. One of them, q, should be as near as possible to k. The interior of this whirling ring has a groove, past which it is possible to slip, accurately and firmly, a black disc, $a'\,b'$, touching the rim at only three points. The black discs

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* *Stars and Telescopes*, Sampson Low, Marston & Co., 1900, p. 463.

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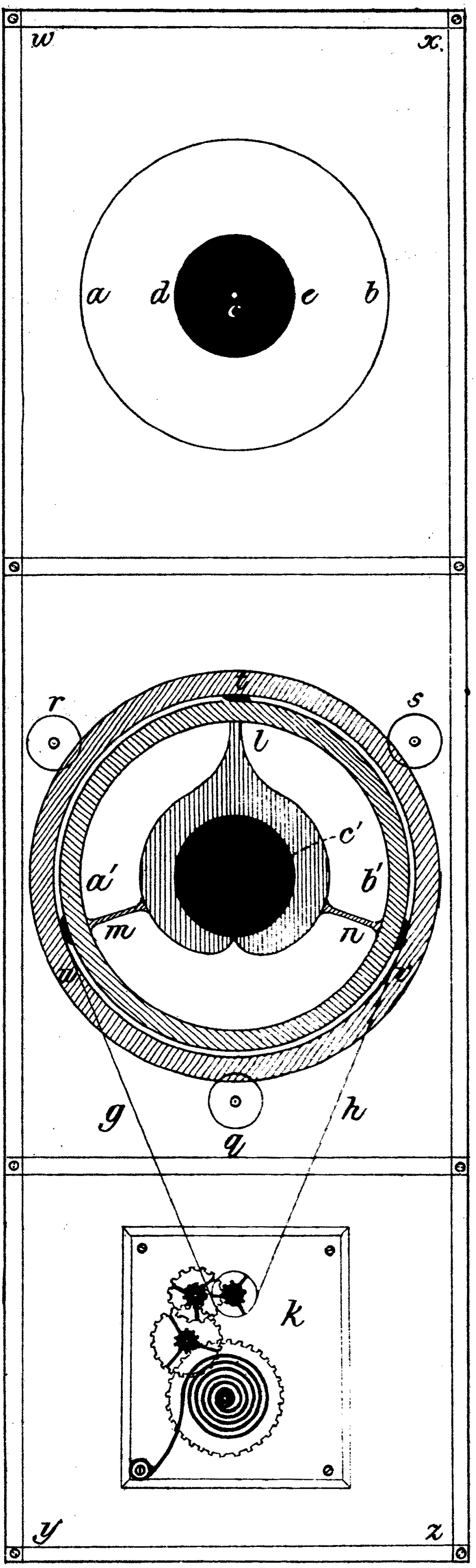

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are cut to any figure desired, from stiff corrugated strawboard packing, double faced. This is very strong; the finished disc or occulting screen weighs less than a half-ounce, and to change one disc for another occupies but four or five seconds.

The critical part of the apparatus is of course the heart-shaped figure within *a′ b′*, and attached to it at the points *l*, *m*, and *n*.

By carefully calculating the relative arc-values of exposure, central about *c′*, it is easy to lay out a curve, point by point, and cut the corresponding disc, which, as the occulter whirls round, shall give any desired integral of exposure to the corona on a single plate, from $0^{s}\cdot1$ close to the Moon's limb up to 30^{s} at 30′ distance.

The extraordinary length of totality in 1901 affords a ready opportunity for the substitution of several discs, calculated on different data as to the actinic intensity of the coronal light at various distances from the limb. There will be abundant time also for two or three exposures with each type of occulting disc. The size of the Moon's disc in the instrument I have adapted is $1^{m}\cdot8$—a 12-inch metal speculum of 15 feet focal length. For the photographic part I am depending upon the Standard Eastman films backed, as exhibiting less halative effect than glass plates. The mirror has a simple mounting moved by the glycerine clock, which affords that readiness of quick and accurate adjustment necessary to get the Moon's image exactly central round the *c′* of the occulter, and to maintain it there during the long totality.

What the new occulter is capable of doing I hope to be able to tell better after the eclipse is over. In rebuilding it I should make two further improvements: (*a*) to put the occulting disc within a few millimetres of the focal plane; (*b*) to rotate it by a clockwork whose rate is instantly changeable within wide limits, as I think the occulter should turn round not only at a perfectly uniform rate, but should make only one complete rotation during a single exposure, whatever its length. But these changes must be reserved for 1904.

Mean Areas and Heliographic Latitudes of Sun-spots in the year 1900, deduced from Photographs taken at the Royal Observatory, Greenwich, at Dehra Dûn (India) and in Mauritius.

(*Communicated by the Astronomer Royal.*)

The results here given are in continuation of those printed in the *Monthly Notices*, vol. lxi. p. 3, and are deduced from the measurements of photographs taken at the Royal Observatory, Greenwich; at Dehra Dûn, India; and at the Royal Alfred Observatory, Mauritius.